

## **REMARKS**

Further and favorable reconsideration is respectfully requested in view of the foregoing amendments and following remarks.

### **Amendments to the Claims**

Claim 1 has been amended to incorporate the limitations of claims 6, 7, 13, 14, 15, 17 and 18, as a result of which these claims have been cancelled. Additionally, claim 1 has been amended to insert the language “to obtain a bainite microstructure” after the controlled cooling step. Support for this amendment is found on page 4, lines 13-16 of Applicants’ specification. Claim 20 has been amended to depend on Claim 19. Claim 20 has been amended to limit the Rm to 1000-1300 MPa and the Re to greater than or equal to 900 MPa. Support for these amendments is found on page 9, lines 26-28 of Applicants’ specification. The claims have been further amended to make minor changes of an editorial nature. Claims 12 and 16 have been cancelled.

Although these amendments are presented after final rejection, because they are made in order to place the application in condition for allowance, the Examiner is respectfully requested to enter and consider the amendments.

### **Arguments Concerning Prior Art Rejections**

The patentability of the present invention over the disclosures of the references relied upon by the Examiner in rejecting the claims will be apparent upon consideration of the following remarks.

### **Rejection Based on Nakamura et al.**

The rejection of claims 1, 5-10, 12, 13 and 16-21 under 35 U.S.C. § 103(a) as being unpatentable over Nakamura et al. is respectfully traversed.

As discussed above, Applicants have amended claim 1 to more specifically define the steel, wherein the steel comprises elements which improve its machinability, where the precipitation annealing is performed in optimal conditions according to the steel composition (specifically, the presence of Cu or V or Ni and Al), where the structure is entirely bainitic due to the controlled cooling of the blank, and where the hot deformation is forging.

Forging rather than hot rolling

Nakamura et al. describe steels for welded sheets, (see abstract of reference) having a very low C content and a high toughness, but relatively low yield strength and tensile strength. The entire specification of Nakamura et al. teaches hot rolling steel slabs and making steel plates. (See column 2, line 34 and column 6, lines 30-40 of the reference.) On the contrary, Applicants' amended claim 1 requires that the hot deformation is forging.

The Examiner admits that Nakamura et al. fail to teach forging. However, the Examiner takes the position that hot forging would not be a patentable difference since it would be a matter of choice well within the skill of the artisan to substitute hot rolling with hot forging. However, Applicants respectfully submit that this assertion is based solely on hindsight, which is improper according to U.S. practice. The Examiner has cited no evidence to support his conclusion that it would have been obvious to substitute hot rolling with hot forging in the teachings of Nakamura et al. In the absence of such evidence, Applicants respectfully submit that the rejection based on Nakamura et al. should be withdrawn. In re Zurko, 59 USPQ2d 1693.

Furthermore, hot forging can not be substituted for hot rolling for the following reasons:

- (1) The deformation speeds are very different for hot rolling versus forging, particularly for hot rolling sheets; and
- (2) The temperature is higher for forging long products than for hot rolling sheets.

In Nakamura et al., the initial hot rolling temperatures are about 950°C – 1250°C or 900°C – 1150°C. On the contrary, the forging of Applicants' claimed invention occurs in the range of 1100°C to 1300°C. These high temperatures are necessary to obtain convenient deformation rates and speeds during forging.

Nonetheless, the Examiner has provided no evidence to support the assertion that hot forging can be substituted for hot rolling.

Pcm Value and high weldability

Nakamura et al. teach that a high weldability is fundamental for its steels, since the reference teaches that Pcm can not more be more than 0.28. (See column 5, line 49 of the reference.) Nakamura et al. state, "Pcm is an indicator of susceptibility to weld

cracking. When the value of Pcm ... is not more than 0.28, no weld cracking occurs under ordinary welding conditions... the Pcm value is desirably as small as possible.” (See column 5, lines 50-56 of the reference.) On the contrary, the Pcm values of Applicants’ examples are 0.282 (Example 1), 0.328 (Example 2) and 1.104 (Example 3). Therefore, the Pcm values of Applicants’ examples are clearly higher than those of the reference, thus indicating that a high weldability is not required for Applicants’ invention. Furthermore, Nakamura et al. teach away from Applicants’ invention by stating that Pcm cannot be more than 0.28.

*Bainitic Microstructure and Machinability*

Applicants have also amended claim 1 to recite that the steel has a bainite microstructure. This microstructure is obtained by the combination of the specific steel composition and the thermal treatments, in particular the controlled cooling step, which takes place in still or forced air at a very low cooling speed when the steel is between 600 and 300°C.

On the contrary, Nakamura et al. teaches that very low cooling speeds are to be avoided, in order to not form a bainite structure containing coarse carbides. Specifically, Nakamura et al. state “when... the cooling is carried out at a cooling rate of not slower than 1°C/sec, the formation of a bainite structure containing coarse carbides can be suppressed.” (Emphasis added.) Therefore, Nakamura et al. teach away from the bainite microstructure, as required by Applicants’ amended claim 1. The reference teaches that this type of microstructure is to be avoided. MPEP 2141.02, VI, teaches that the prior art reference must be considered in its entirety, i.e., as a whole, including portions that would lead away from the claimed invention. The Nakamura et al. reference, taken as a whole, teaches away from Applicants’ claimed invention.

Further, nearly all the cooling speeds of Table 3 of Nakamura et al. are higher than Applicants’ recited cooling speed. These speeds are probably average speeds for the period extending from the beginning to the end of the cooling. In some cases, the steel is “allowed to cool”, and probably cools at lower speeds. However, nothing is said concerning the precise cooling speed between 600 and 300°C, which is the criteria to consider for determining if the obtained structure is bainite or not. It is likely that at these

temperatures the cooling speed is higher than the average speed calculated for the whole cooling step, to avoid the formation of bainite microstructure.

Additionally, it is important to consider the thickness of the steel part. In Nakamura et al., the product which is “allowed to cool” in some instances is a hot-rolled sheet. Therefore, the product is a relatively thin product which is likely to cool at a relatively high speed, likely exceeding 3°C/s between 600 and 300°, even in still air. On the contrary, the product of Applicants’ invention is a forged product, which is relatively thick in most cases, for which a low natural cooling speed between 600 and 300°C is easily obtained.

The homogeneous bainitic structure of Applicants’ invention, obtained due to the slow cooling performed just after forging, is far superior for machinability than the at least partially martensitic structure of Nakamura et al. Further, the annealing as optimized according to the steel composition (based on the presence of Cu, V or Ni and Al) helps to obtain a good fractioning of the chips during machining, at least when Cu is added. Additionally, the machinability of the Applicants’ recited steels is improved by the addition of Ca or Te or Se or Bi or Pb, as now recited in amended claim 1.

Further, the steels of Applicants’ invention have a good resistance to fatigue, due to their bainitic structure. (See page 1, lines 34-35 and page 3, line 35 – page 4, line 12 of Applicants’ specification.) The steels of Applicants’ invention are also well adapted to surface treatments, such as induction quench and nitriding, which improve the fatigue resistance, also due to the bainitic structure.

#### Comparison of Examples of Nakamura et al. with claimed invention

The Examples of Table 1 concern steels for which the conditions of hot-rolling are unknown. In particular, the thickness of the steels is not known. Additionally, none of the steels of Table 1 contain boron, which is required by Applicants’ claim 1. Only steels 1, 2, 6, 11, 19, 25, 29, 31 and 32 have all the required elements within the ranges of the invention; and only steels 11, 19, 25, 31 and 32 also fulfill the limitation that  $Ti \geq 3.5N$ . Of these steels, only steel 19 has undergone a slow cooling (air cooling), but it is unknown what the speed is between 600 and 300°C because the thickness of the sheet is not known.

Additionally, only steel 31 has both a YS (Re) and a TS (Rm) according to what the invention aims at obtaining, and as recited in Applicants' amended claim 20.

However, the microstructure of steel 31 is not known. Since the cooling speed of steel 31 was high, at least above 480°C (18°C/s), it cannot possess a bainite microstructure. The good mechanical properties are obtained only because an annealing at 560°C was performed. This is at a higher temperature than the 500°C maximum required in Applicants' invention for Cu-containing steels. One of the advantages of Applicants' invention is to allow lower annealing temperatures for obtaining the desired mechanical properties.

Therefore, none of the Examples of Table 1 satisfies each of the requirements of Applicants' amended claims.

Among the Examples of Tables 2 and 3 of Nakamura et al., only steels L and M have compositions according to the invention. Sample 63 (Steel L) was cooled in air, but since its hot rolling (performed at a low temperature of 820°C) gave it a low thickness (25mm), the cooling speed is likely much higher than that recited in Applicants' claim 1. In fact, the Rm of Sample 63 (576 MPa) is much lower than that required by Applicants' amended claim 20 (greater than or equal to 900 MPa). Sample 64 (Steel M) was hot rolled at a low temperature (820°C), cooled at a speed higher than that permitted by Applicants' claim 1 (4.8°C/s down to 360°C) and annealed at 650°C, which is higher than permitted by Applicants' claim 1. These differences result in a lower Rm (664) than permitted by Applicants' amended claim 20.

Therefore, none of the Examples of Tables 2 or 3 satisfies each of the requirements of Applicants' amended claims.

#### Discussion of Amended Claim 20

Applicants' claim 20 has been amended to recite a tensile strength Rm of 1000 to 1300 Mpa, and a yield strength Re of greater than or equal to 900 MPa. None of the Examples of Nakamura et al. have a Rm exceeding 856 MPa, and most are between 600 and 700 MPa. In fact, higher Rm values would be detrimental for the high toughness which is required for the steels of Nakamura et al.

For these reasons, the invention of claims 1, 5-10, 12, 13 and 16-21 is clearly patentable over Nakamura et al.

**Rejection Based on JP '246**

The rejection of claims 1 and 5-21 under 35 U.S.C. § 103(a) as being unpatentable over JP '246 is respectfully traversed.

JP '246 describes steels for making injection or extrusion molds. (See page 3, line 11 of the electronic translation.) A good toughness, good machinability, good crimp properties, and high possibilities to obtain mirror finishing properties which are essential for obtaining smooth surfaces for the molded plastics are required by JP '246. None of these properties is necessary for Applicants' recited steel. Further, the steels of JP '246 must have a high corrosion resistance, since at their injection temperatures, plastics are highly corrosive. (See paragraph 15 of the translation.)

The following are differences between the teachings of JP '246 and Applicants' recited invention. Ni, Cu and Al are all required in JP '246, while either Cu, or Ni and Al are present in Applicants' steel, where they can also be replaced by V, which is only optional in JP '246. None of the examples of JP '246 satisfies all of the requirements of Applicants' amended claim 1. None of the Examples of JP '246 teaches boron, which is required by Applicants' claim 1. A does not contain Ti, and therefore cannot satisfy the requirement that  $Ti \geq 3.5N$ . B contains too much Ti, and contains 0.20% Nb, which is far higher than the 0.06% permitted by Applicants' claim 5. C has too much Ti. D does not contain Ti, and therefore cannot satisfy the requirement that  $Ti \geq 3.5N$ , and also contains W. E does not contain Ti, and therefore cannot satisfy the requirement that  $Ti \geq 3.5N$ , and also does not contain enough C. F contains too much Ti and Nb, and also contains W. G does not contain Ti, and therefore cannot satisfy the requirement that  $Ti \geq 3.5N$ . H does not contain Ti, and therefore cannot satisfy the requirement that  $Ti \geq 3.5N$ , and also contains W. Therefore, none of the Examples of JP '246 satisfy all of the limitations of Applicants' amended claims.

Regarding the thermal treatments, after forging or hot rolling, JP '246 practices a cooling from  $900^{\circ}C$  at more than  $0.5^{\circ}C/s$  (paragraph 17) and keeps the product during at least 1800 s (1/2 h) within the lower bainitic domain (see Table 2). In Applicants' invention, the critical temperature range is  $600-300^{\circ}C$ , in which the cooling speed must

be kept at most at 3°C/s in order to form upper bainite, and not lower bainite as in JP ‘246. Therefore, Applicants’ claims require a maximum cooling speed in a temperature range not particularly considered by JP ‘246, while JP ‘246 requires a minimum cooling speed over a wide temperature range, together with an isothermal treatment not required by Applicants’ invention. The cooling speed of JP ‘246 can reach 5°C/s (see Table 2). Concerning the hot deformation temperature, JP ‘246 is not very explicit, but the fact that the cooling starts at 900°C only shows that the hot deformation takes place at a slightly higher temperature. The minimum temperature required by Applicants’ claim (1100°C) is far higher than 900°C and there is no teaching or suggestion in JP ‘246 to choose such a high temperature. Applicants respectfully submit that the Examiner’s assertion that a prior art hot deforming temperature of greater than 900°C would closely approximate Applicants’ claimed range of 1100 to 1300°C is based on hindsight, which is improper according to U.S. practice. The Examiner has cited no evidence to support his conclusion. In the absence of such evidence, Applicants respectfully submit that, the rejection based on JP ‘246 should be withdrawn. In re Zurko, 59 USPQ2d 1693.

Further, paragraph 6 of the translation of JP ‘246, which discusses another document concerning the same technical field, teaches that the hot working temperature is only 700 - 900°C. So, high hot working temperatures are not particularly considered for making extrusion/injection molds.

Concerning the structure, JP ‘246 seeks to obtain lower bainite, because it is harder and tougher than the upper bainite, and is able to be mirror polished. These properties are not required in Applicants’ invention, which does not rely on obtaining a particular type of bainite. Practically, upper bainite is the result of the coupled composition and thermal treatments of the invention.

JP ‘246 and the invention also differ on the fact that JP ‘246 does not require particularly high Re and Rm : only high toughness and hardness are required. This justifies the presence of W, which is a hardening element, excluded from the invention.

So, JP ‘246 does not show or suggest the particular combination of composition and process features of claim 1, for obtaining steels having the required particular properties.

For these reasons, the subject matter of claims 1 and 5-21 is clearly patentable over JP ‘246.

Therefore, in view of the foregoing amendments and remarks, it is submitted that each of the grounds of rejection set forth by the Examiner has been overcome, and that the application is in condition for allowance. Such allowance is solicited.

Respectfully submitted,

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